Astronomy 201 / Physics & Astronomy Department

Stars, Galaxies & the Universe

Spring Semester 2018 / Syllabus

Instructor:	Eugene H. Levy
Physical Location:	318 Herman Brown Hall; 713-348-4121
Virtual Addresses:	Email: ehl@rice.edu | Home Page: http://ehl.web.rice.edu
Class Website Portal:	CANVAS
Lectures:	Tuesdays & Thursdays, 9:25 - 10:40 am Keck Hall 100
Office Hours:	Following Thursday class & flexible by appointment

The course is intended to satisfy Group III distribution requirements. Students majoring (or intending to major) in astronomy/astrophysics should consider alternative astronomy courses, such as ASTR 350/Introduction to Astrophysics-Stars, which provide credit toward the major degree, though they are, of course, welcome here as well.

Course Objectives

The observable universe seems to have originated, about 13.8 billion years ago in an event we call the *Big Bang*. We inhabit a small rocky, wet planet, orbiting -- along with a handful of other planets -- around an ordinary, otherwise undistinguished, star, the Sun, in an otherwise obscure region of a galaxy called the *Milky Way*. This galaxy contains more than 100 billion other stars, some larger than the Sun, some smaller, some older, some younger. The part of the universe we can see contains an estimated 100 billion other galaxies -- some larger, some smaller than ours, some with more stars than our galaxy, some with fewer. The planet on which we live, Earth, formed, along with seven other surviving planets (and myriad smaller objects), around the Sun at the same time that the Sun itself formed, about 4 1/2 billion years ago, by which time our universe had already evolved through 2/3 of its current age. We call this system of the Sun, along with its associated planets and moons, and swarm of orbiting debris, the Solar System. So far as we know, the Solar System is not special in the Universe, and occupies no special position.

The best evidence indicates that life has been present on Earth throughout most of our planet's existence, apparently having started between 3 1/2 and 4 billion years ago, relatively soon after the formation of Earth itself. For most of Earth's history, terrestrial life consisted entirely of microbes. Only during the most recent billion years or so has multicellular life -- descended from symbiotic colonies of those microbes -- existed on our planet. We humans, only very recently, developed out of these antecedents, and evolved to our current state gradually over the past several million years. The total time over which terrestrial humans (or proto-humans) have existed spans a mere one-tenth of one percent of the age of Earth, and about one-thirtieth of one percent the imputed age of the universe.

We live at an extraordinary time. After all the years of development, from single cells to complex human beings, modern civilization, with mass agriculture supporting vast technologically-based

urbanization, emerged only over the past 10,000 years or so, and most impressively during the last 500 years. One of the singular features of this most recent era has been our development of reliably explanatory scientific understanding. This science gives us an unprecedented ability to learn about our planet, our solar system, our universe, and eventually ourselves, in remarkable depth. And it has given us the ability to begin to elucidate and understand the history and processes that produced us and shaped the terrestrial and cosmic environments on which our sustained existence depends.

This endeavor of understanding is made possible by the fact that our universe appears to be a *cosmos*, as that word was understood by early Greek philosophers:

> *Merriam-Webster Dictionary:*
> **COSMOS** 1. an orderly harmonious systematic universe -- cf. CHAOS

The apparent order, harmony, and systematic nature of our universe is reflected in the fact that the universe seems to be governed by regular, reliable laws, which, remarkably, are discoverable by human intelligence. Although we, by now, know a great deal, with high certitude, there is still a great deal that we do not yet know. The focus of this course is to explore our understanding of the cosmos of which we are a part, and within which we have emerged. This course will introduce the materials, forces and classes of objects that comprise the universe, and explore their distribution and development through space and time, as well as some of the processes that govern their appearance and behavior. We will emphasize how the known facts and laws of nature -- including the forces, laws of motion, and the structure of matter -- work to shape and control our world, and help us to understand what we see and experience.

We are, ourselves, a cosmic phenomenon, born of the same material and out of the same processes that shape the universe around us. In a narrow sense, this course studies the objects and processes that shape the astronomical universe, in a broader sense, this course is also an introspection into the context, events, and history of our own existence. We study the universe not only to understand the surrounding universe, but also to inform and enlarge our understanding of ourselves.

The primary conceptual aims of this course are: 1) to explore what scientific inquiry has revealed about the nature and history of the universe, and the processes that shape it; 2) to help you comprehend how the physical forces and the structure and behavior of matter shape the physical world; and 3) to help you gain appreciation of how we know what we know, and why we are able to be confident in that knowledge, while, at the same time, being aware of the boundaries that separate confident knowledge from uncertainty and areas of still-persisting ignorance.

Prerequisites

No special scientific or mathematical background beyond familiarity with typical high school physics, chemistry and algebra is assumed or needed for this course. Calculus will not be required, but we will engage rudimentary equations (algebra) and calculations. These will be designed to reinforce what you learn, and help strengthen your skills in applying quantitative reasoning. Examples relevant to the homework will be worked through in class.

One of the animating motives of this class is to help you learn how much you can understand on the basis of relatively simple ideas and concepts, without getting lost in a blizzard of details.

Learning Outcomes

The specific learning outcomes aimed at in this course focus on:

- Developing knowledge of basic scientific principles, and of how these principles are employed to advance and secure understanding of our world
- Advancing knowledge of the crucial roles played by observations, experiments and exploration in securing and understanding our world.

- Elucidating how the nature and behaviors of objects and systems throughout the universe are related to the underlying physical laws and properties of matter.
- Exploring the nature of light and how our understanding of the interactions of light and matter play such an important part in advancing our knowledge.
- Elucidating how we have been able to develop knowledge of the history and timescales of cosmic processes and events that produced -- and continue to sustain -- our surroundings.
- Exercising skill in the rudimentary application of basic mathematics (arithmetic) to understanding our world and phenomena around us.
- Developing an appreciation for the contingency and moving boundaries of knowledge, helping to perspective about the difference between what we know with high certitude, and what we do not know, and why.

Course Textbook

The text for the course is:

> ***The Cosmic Perspective*** (8th or 7th edition is acceptable)
> by Bennett, Donahue, Schneider and Voit; Pearson (Addison-Wesley)

The above, full, version of the textbook also covers the material for ASTR-201 (Stars, Galaxies and the Universe). If you buy the book new and want the most up-to-date version, get the 8th edition. However, you will not be disadvantaged in this class by using the previous, 7th, edition.

This course covers (selectively) material that overlaps with Chapters 1-6, and 14-22 of the textbook.

Class Website

Course materials including problem sets, scores & grades, links to relevant websites, and supplementary material, as well as class updates and announcements will be posted on, ***or linkable from***, the Rice CANVAS webpage for this course. You are responsible for reading emails from the class website and checking the CANVAS course website regularly for up-to-date posted information. Homework assignments and tests will be distributed and collected through the CANVAS website. Assignments and tests are to be turned in as single PDF files deposited in CANVAS.

Additional information and material of interest (including about scores on assignments and tests) may be posted on an alternate course website, with will be linkable both from the CANVAS course site or from a labeled button at the website: http://ehl.web.rice.edu.

Special Needs

Any student with a documented disability needing academic adjustments or accommodations should speak with the instructor, preferably during the first two weeks of class. All such discussions will be held confidential. Students with disabilities will need to contact Disability Support Services in the Ley Student Center: http://dss.rice.edu.

Adherence to Honor Code

The Rice Honor Code applies to all assignments and activities in this class. All students should be familiar with Honor Code and Council rules and procedures, which can be found at http://honor.rice.edu. Be aware that, under Rice rules, an instructor is afforded little discretion in reporting suspected violations, and is required to report such suspicions to the Honor Council for independent disposition. *See the next section for guidelines/rules pertaining to work submitted for this class.*

Homework &Tests

In addition to reading and study assignments from the text book, there will be regular homework, and occasional tests. Homework assignments and tests will be distributed and collected through the CANVAS website. Assignments and tests are to be turned in as single PDF files deposited in CANVAS; no other form will be accepted.

Homework: Weekly homework assignments with questions and problems based on material covered during the previous week (or weeks) in the textbook or in class lectures. Homework assignments will be posted on CANVAS each Tuesday, and normally be due in class (or immediately before class if submitted online) the following Tuesday, unless otherwise specified in writing. For the homework, you may consult the textbook, your notes, and other materials, including the Web, unless otherwise indicated in writing. You may (and are encouraged to) discuss general concepts and approaches before answering the questions, but the answers and work you submit must be entirely your own, based on your own understanding. Occasionally, for a homework question/problem, you may need to seek information available from the Web.

Late homework will not be accepted, and will be scored zero. In computing the semester grade, each student's two lowest homework scores will be discarded.

Tests: There will be two tests, one midterm test during the first half of and one end-term test during the last week of class; the end-term test will focus on class material from the second half of the semester, covered since the first test, but you should keep in mind that, as in most science disciplines the material is inherently cumulative, and material from the first part of the semester will be inherent in the second-semester material. For both tests you may consult both the text book and your own class notes. However, no other materials or sources, including web browsing, will be permitted: Each student is to complete the tests on her or his own, with no consultation. The tests will be similar to the homework in nature, except that each will cover a broader segment of the course, and be pledged under the Rice Honor Code as your own independent work. The tests will be "take-home" tests.

There will be no final exam.

Attendance and Participation

Students should plan to attend class regularly. Those who do not are likely to find themselves at a significant disadvantage, as, frequently, material will be covered in the lecture that is not be covered to similar depth in the book. Moreover, some examples discussed or worked through in class are likely to be reflective of material in the homework or on tests. You are expected to be present and participate in class. Attendance will be taken (with a sign-in sheet passed around at some point during each class period). Those with attendance rates above about 90% (specifically, with no more than 3 recorded absences in the semester) will be awarded a 1/3 grade-step boost in the final grade. Those with attendance rates below about 70% (specifically, with more than 8 recorded absences) will have a 1/3 grade-step reduction in the final grade. [I appreciate the fact that seat time is not a reliable indicator of learning, but neither are isolated homework-and-test-question answers.]

If there is some systematic circumstance that affects you in regard to reasonably regular class attendance -- and if you care about this factor -- please see the professor as soon as possible.

Grades

Course grades will be based on the homework, the mid-term & end-term tests:

50%.....Homework
25%.....Mid-term test
25%.....End-term test

The final assignment of letter grades may be adjusted on the basis of outcomes rather than based on a rigid, predefined scale. Every student who regularly and attentively attends class, and who attentively carries out the reading, study and homework assignments, should be able to achieve a fine grade in this class.

Machines in the Classroom

Cell phones should be turned off -- or rendered silent -- within the classroom. (If circumstance requires that you take an urgent call during the class, please try to take it out of the room.) Laptops or other small devices may be used for class purposes such taking notes. Other uses (browsing, email, etc.) are distracting and disruptive; please be responsible, considerate, and mature in your use of technology appliances during class. (The nature of the course material is such that hand written-and-drawn notes -- with sketched illustrations -- are likely to prove far more useful than typed notes.)

The Campus Observatory

The Rice University Campus Observatory (RUCO: www.ruf.rice.edu/ruco/observatory.html provides opportunity for hands-on observation of astronomical objects. Observing sessions are scheduled during the semester, and students are encouraged to take advantage of the opportunities offered by this excellent on-campus facility. Earth-based astronomical observing is subject to weather and local "seeing" conditions. Observing sessions may be organized or cancelled on unavoidably short notice. The nights for practical astronomy are associated with clear, cold weather conditions, so you are advised to dress warmly.

Issues or Problems

If you experience issues, difficulties, or misunderstandings that affect you in this class, you are strongly encouraged to speak directly with the professor as soon as you can.

This Syllabus is Subject to Possible Change

The information in this syllabus is subject to possible revision during the semester. If any changes are made, enrolled students will be notified in a timely manner.